16:10:10 OCA PAD INITIATION - PROJECT HEADER INFORMATION 05/12/89

Active

Project #: E-16-A12 Cost share #: Rev #: 0
Center # : R6317-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: SUBCONTRACT TO GRANT 14544 Mod #: Document : CONT
Prime #: 14544 Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: AE Unit code: 02.010.110
Project director(s):
GIDDENS D P** AE (404)894-3781

Sponsor/division names: EMORY UNIVERSITY / ATLANTA, GA
Sponsor/division codes: 400 / 012

Award period: 890101 to 901231 (performance) 910131 (reports)

Sponsor amount	New this change	Total to date
Contract value	39,129.00	39,129.00
Funded	39,129.00	39,129.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: THE ROLE OF FLUID MECHANISMS IN CORONARY ATHEROGENESIS & ATHEROSCLEROSIS

PROJECT ADMINISTRATION DATA

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ATLANTA GA 30322

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A N/A supplemental sheet
Equipment title vests with: Sponsor GIT
NONE PROPOSED.

Administrative comments -
INITIATION OF PROJECT.TERMS & CONDITIONS OF PRIME GRANT FROM R WOODS JOHNSON FOUNDATION APPLY.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

PROJECT SUMMARY
CLOSEOUT COMPLETE

Closeout Complete Date 03/26/91

Project No. E-16-A12 Center No. R6721-0A0

Project Director GIDDENS D P** School/Lab AERO ENGR

Sponsor EMORY UNIVERSITY/ATLANTA, GA

Contract/Grant No. SUBCONTRACT TO GRANT 14544 Contract Entity GTRC

Prime Contract No. 14544

Title THE ROLE OF FLUID MECHANISMS IN CORONARY ATHEROGENESIS & ATHEROSCLEROSIS

Effective Completion Date 901231 (Performance) 910131 (Reports)

Closeout Actions:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	910108
Final Report of Inventions and/or Subcontracts	N	
Government Property Inventory & Related Certificate	N	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

Comments

Subproject Under Main Project No.

Continues Project No. E-25-678

Distribution:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other	N
	N

Progress Report on the Robert Wood Johnson Research Grant with Emory University
January 1, 1990 thru December 31, 1990

The personnel at Georgia Tech have continued their support in this project which investigates the fluid mechanics of diseased coronary arteries. Scaled up models of these arteries have been examined in more detail, and work on the use of Doppler ultrasound in arterial diagnosis has continued.

The Georgia Tech personnel have assisted in the design and operation of flow models and in the collection and processing of data for both in vitro and in vivo studies. They have also assisted in the interpretation of signals derived from intraluminal coronary Doppler ultrasound devices.

Experiments on the branched coronary artery model described in the previous report have been expanded upon to control and monitor the background vibrations which can initiate or modify turbulent flows. It was shown that these vibrations do affect the turbulent transitions for the specific flow field studied here, and the frequencies of vibration that affect the flow were characterized. The earlier conclusions about the effect of branching on turbulence were verified by these experiments.

Similar experiments were performed on an asymmetric stenosis model. Again, vibration frequencies and conditions for turbulent transition were characterized. The results are of interest clinically because of associations between shear stress, which is elevated by turbulence, and atherosclerosis, intimal hyperplasia and thrombus formation.

In vivo and in vitro evaluation experiments have been performed on three intraluminal coronary Doppler ultrasound devices. These are: 1) The 20 MHz and Millar Doppler catheter; 2) The 12.5 MHz Cardiometrics guide wire; and 3) The 20 MHz Numed catheter. Results show that the guide wire may have significant advantages over the earlier Millar design for the measurements of flow rate, but that numerous problems remain to be solved. The modern spectral analysis techniques which have already been examined by Georgia Tech personnel have been used extensively in this research. Also, a simulation program which was developed at Georgia Tech and which models Doppler quadrature signals has been of use in the interpretation of the intraluminal devices.

This project is an investigation into the fluid mechanics of coronary arteries. The fluid mechanical factors involved in the genesis, progression, and consequences of coronary artery disease are being studied at Georgia Tech through scaled up models of coronary arteries. Furthermore, possible techniques of coronary diagnosis through Doppler ultrasound are being studied.

The Georgia Tech personnel are involved in this research in several aspects. They provide guidance for the design and operation of the flow models, they design and implement the programs for data collection and processing, they provide technical assistance for instrumentation involved in in-vivo experiments, and they implement research designed to study the effect of signal processing techniques on the Doppler ultrasound catheter used in coronary artery diagnosis.

Flow model studies have centered around a model which incorporates the branching structure of the coronary arteries into the flow downstream of an occlusion which represents an atherosclerotic lesion. Results from this model have shown that the relative locations of the lesion and the branches affect the location of turbulent transition downstream of the stenosis. This in turn can effect the shear stress distribution in this region. Since low shear stress has been associated with atherosclerosis, this result implies that the growth of atheroscerotic lesions will be affected by the location of the lesion. Thus the prognosis, and hence the recommended treatment, for a patient will depend on this location.

Research with a 20 MHz Doppler ultrasound catheter has shown severe limitations to the current design and use of this device. It is now clear that this design cannot be used to measure flow rate, the ideal measure of arterial patency, in the coronary arteries Furthermore, there are difficulties with relative indices, such as coronary blood flow reserve (CBFR) derived from measurements made with this device. The difficulties include the wake downstream of the catheter, the difficulty of placing the catheter, and relatively low signal to noise ratios. The catheter sample volume is too small to obtain a true flow rate, yet too large to measure velocity. Studies are underway to determine which of these problems are the most limiting. The wake of the catheter has been studied in depth through in vitro measurements. It has been shown to depress the velocity estimation. This depression depends on Reynolds number such that velocities in large Reynolds number flows are underestimated to a greater extent than velocities in low Reynolds number flows.

Experiments with modern signal analysis methods on signals from the 20 MHz Doppler ultrasound catheter have shown that these methods can improve the ability to obtain good velocity signals. Velocity estimates showed better accuracy and less variability when a maximum likelihood method was used on the quadrature signals as opposed to the more traditional Fourier method. Autoregressive and maximum likelihood methods also provided more stable spectra. These spectra have diagnostic potential because they relate directly to the velocity profiles.